2. On the Anatomy of the African Jumping-Hare (*Pedetes caffer*) compared with that of the *Dipodidæ*. By F. G. Parsons, F.R.C.S., F.Z.S., F.L.S., Hunterian Professor at the Royal College of Surgeons and Lecturer on Comparative Anatomy at St. Thomas's Hospital.

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The opportunity of dissecting a somewhat rare Mammal, the African Jumping-Hare (*Pedetes caffer*), was kindly given me by Mr. Oldfield Thomas, of the British Museum. Fortunately the adult specimen was a female, and its uterus contained an embryo which must very nearly have reached its time of birth. Mr. Beddard, the Prosector of this Society, has also kindly placed at my disposal two Jerboas (*Dipus jaculus* and *D. hirtipes*) for comparison.

At the end of the paper will be found a short summary of its chief points of interest.

External Anatomy.

The total length from the snout to the root of the tail is 17 inches, the tail measuring another 18 inches.

The nose is covered by very short fine hair except round the nostrils, where the skin is bare. The upper lip is very long; there is an interval of one inch between the lower part of the nose and the mouth; there is no cleft in the median line, and the space between the nose and the mouth is covered by thick short fur.

The aperture of the mouth is crescentic, the upper lip being curved to expose the incisor teeth, which are white and perfectly smooth. The pointed ears are $3\frac{1}{2}$ inches long, and from the ventral side of the meatus the tragus projects as a conical process $\frac{1}{3}$ of an inch high. The fore limbs are set very far forward, indeed there are only 2 inches between the point of the shoulder and the posterior canthus of the eye; they are very short, the upper arm being especially diminished. The manus has five well-marked digits provided with laterally compressed, pointed, slightly curved claws; the most radial of these, the pollex, is the shortest. In the palm of the hand are two processes; the more radial of these is hemispherical and is situated opposite the base of the outer two digits, its radial side is flattened and is covered with much harder epidermis than the rest, giving an appearance very like that of a small human thumb-nail. On the ulnar side of this is a smaller elevation which is compressed laterally and, unlike the other, covered with hair; it is also much the softer and more freely movable of the two.

There are two pairs of nipples; the more anterior are situated just behind the axilla, 2 inches from the middle line, while the more posterior are $1\frac{1}{2}$ inches behind these and a little nearer the mid-line. There are no inguinal or abdominal nipples.

The hind limbs are very long and the knee and hip-joints are

strongly flexed, while the most comfortable position of the ankle seems to be one of extreme dorsal flexion, so that the dorsal surface of the foot is in contact with the shin as far as the heads of the metatarsal bones. There are four toes in the foot, the hallux being absent and the most fibular toe the smallest; they are provided with strong triangular claws compressed from above downward. The second toe from the tibial side is the largest.

The vagina and rectum open by a common aperture 2 inches below the root of the tail; it is soon divided into a smaller rectal part and a larger vaginal. On each side of the vulval orifice is a crypt about $\frac{1}{8}$ inch deep, and this leads by a wide orifice into a thick-walled, almond-shaped sac $\frac{1}{2}$ inch long. When this sac is opened up, it is seen that at the orifice the mucous membrane has longitudinal rugæ, but that nearer the fundus it is covered with hairs about $\frac{1}{8}$ inch long. The walls are evidently glandular and the cavity contained a quantity of inspissated secretion [1].

On comparing the external anatomy of *Pedetes* with that of *Dipus* one is struck by the general resemblance between the two; there is the same breadth at the back of the head, and want of proportion between the fore and hind limbs; in *Dipus*, however, the upper lip is divided and the white upper incisors are grooved as they are in the embryo of *Pedetes*. There are four pairs of nipples instead of two as in *Pedetes*; the most anterior pair are situated at the root of the neck, and the most posterior almost opposite the vulval orifice.

In the hand the claws closely resemble those of *Pedetes*, but that on the pollex is quite short. As in *Pedetes* there are two prominent projections in the palm; of these the radial is the better developed, but no nail is present.

In the hind foot there are only three toes, and the claws are more laterally compressed than those of *Pedetes*.

The Osseous System.

As the osteology of *Pedetes* is well known and several skeletons of it exist, I shall only make a brief survey of the bones of the specimen in my possession, comparing them with those of the fœtus and of *Dipus jaculus*.

The dorsal surface of the skull is remarkable for the strength and breadth of the nasals; the frontals too are very large, in the median line they are twice as long from before backward as the parietals, while in *Dipus* the parietals and frontals are of the same length. The interparietal only projects for a short distance between the parietals; in the fœtal *Pedetes* the interparietal is much larger than the adjacent supraoccipital. In the lateral view the infraorbital foramen is deeper in *Pedetes* than in *Dipus*, and in the latter animal there is a small separate foramen below through which the infraorbital nerve makes its exit.

[1] The external anatomy of the fœtal specimen will be found with the description of the uterus.

The temporal fossa in both animals is ridiculously small, and is separated from the orbit by a postorbital process, which is much better marked in *Dipus* than in *Pedetes* and is altogether absent in the fœtus. The squamosal is remarkable for a backwardly projecting process which locks it into the periotic bone; this spur is simple in *Pedetes*, but in *Dipus* it is ⊢-shaped, a vertical bar extending at right angles from the hinder end of the primary horizontal one. The periotic has the usual tympanic canal running upward and backward from the laterally compressed tympanic bulla. In *Dipus* the canal is extremely short, and in the fœtal *Pedetes* there is merely a tympanic ring. Above the external auditory meatus in both animals, the supratemporal bulla gives the characteristic swollen appearance to the hind part of the skull. In the fœtus no bullæ are present; the periotic is a mass of cartilage in which the pro-, epi-, and opisthotic ossifications can be seen. The backward projection of the squamosal is, however, quite ossified.

On the ventral surface of the skull the incisors are perfectly white and quite smooth in *Pedetes*; in *Dipus* they are also white, but there is a single longitudinal groove in them. In the fœtal *Pedetes* it is interesting to notice that the incisors, which are just appearing, are also grooved.

The anterior palatine canals are slit-like and not very large in either animal; in *Pedetes* they are situated at the bottom of a rather deep fossa. The bony palate is one of the chief points of difference between the two skulls: in *Pedetes* it reaches as far back as the first molar tooth, in *Dipus* it extends considerably farther back than the last molar. In the fœtus there are rudiments of three teeth on each side, presumably the premolar and first two molars; the most anterior of the three is the one best developed.

On a level with the hinder edge of the internal pterygoid plate there is in *Pedetes* a small median opening in the basioccipital bone; this communicates with the foramina rotunda, but does not open directly into the cranial cavity. More posteriorly in the midline of the basioccipital bone is a round aperture, large enough to admit a wax vesta match; in the recent state this was closed by membrane. In the fœtal specimen both these openings are present, but they are bilateral instead of median. In *Dipus* neither is present.

In the mandible the chief difference between the two animals is that in *Pedetes* the symphysis, although not synostosed, is immovable; while in *Dipus* the incisors are capable of separation and approximation as in most myomorphine rodents. In addition to this the angular process is much larger in *Dipus* than in *Pedetes* and is perforated by an oval foramen. The lower incisors too of *Dipus* are much more laterally compressed than they are in *Pedetes*.

The *Atlas* of *Pedetes* is remarkable for having on each side three foramina for the vertebral artery; there are the usual two in the transverse process and dorsal arch, and an additional one formed by a small bridge of bone arching over the groove for the artery midway between the other two. In *Dipus* the one in the transvers

process is missing, but the other two are present. In *Dipus* the 2nd, 3rd, 4th, 5th, and 6th cervical vertebræ have their bodies and arches synostosed. In *Pedetes* they are all free, although the 2nd and 3rd are so very close together that hardly any movement can be allowed between them. In neither animal is there a foramen in the transverse process of the seventh cervical or a ventral tubercle, although that of the sixth is very prominent.

The first thoracic vertebra only has half a facet on the cephalic part of the side of the body, because in both animals the head of the first rib articulates as much with the seventh cervical as with the first thoracic. In *Pedetes* the transverse process of the 10th thoracic vertebra has three processes; the most anterior forms a facet for the articulation of the 10th rib, the middle one is directed outward and corresponds to the tip of the ordinary thoracic transverse process, while the most posterior projects backwards.

In the 11th thoracic vertebra the rib still articulates with the anterior of these tubercles, the middle one is reduced in size and the posterior one is larger. In the 12th vertebra the posterior tubercle has become much larger and has developed into a well-marked anapophysis or accessory process, the middle tubercle has completely disappeared, but the anterior is still present, supporting the 12th rib by a definite articular facet.

In the 1st lumbar vertebra the transverse or, as it is often called, costal process is seen to correspond in shape and position with the anterior tubercle of the transverse process of the posterior thoracic vertebræ, and the anapophysis with the posterior tubercle of the same. The mamillary process or metapophysis first appears on the prezygapophysis of the 10th thoracic vertebra and increases in size vertebra by vertebra into the lumbar region; it is quite plain that it has no homology with any part of the thoracic transverse processes. In the lumbar region the anapophyses are very large and rest against the outer side of the prezygapophyses of the next vertebra behind; the prezygapophysis is therefore locked in between the postzygapophysis and anapophysis of the vertebra in front.

After the seven lumbar vertebræ there are four which are fused to form a sacrum, but only two of these support the ilium, the first forming a much larger part of the articular facet than the second. On the ventral side of the disc between the 4th sacral and 1st caudal vertebræ there is a single bony spur, about 5 mm. in length, attached by fibrous tissue to the disc; it lies a few mm. to the left of the median line. Between the first and second caudal vertebræ a small well-marked chevron-bone is present, and this is succeeded by others, the one between the 3rd and 4th being the most prominent. After this the bones gradually shorten and become more and more elongated antero-posteriorly and compressed laterally. Between the 9th and 10th caudal the true chevron-bone ceases, but a pair of bony tuberosities project from the anterior part of the ventral surface of the 10th vertebra; farther back in

the tail these also gradually die away. There are altogether 31 free caudal vertebræ.

The *Sternum* of *Pedetes* consists of the presternum, four mesosternal sternebræ, and the xiphisternum. The presternum is considerably expanded anteriorly, but narrows suddenly behind the attachment of the first rib. The 2nd, 3rd, 4th, and 5th costal cartilages articulate opposite the joints between sternebræ, the 6th articulates with the posterior part of the last sternebra, the 7th articulates with a cartilaginous mass separating the last sternebra from the xiphisternum, while the 8th is attached to the anterior part of the xiphisternum. In the fœtal specimen centres are present for the presternum and first two sternebræ.

The sternum of *Dipus* is very like that of *Pedetes* in the number of elements present; the chief points of difference are that the 8th rib does not reach it and that the first rib is attached nearer the front of the presternum.

The *Clavicle* both of *Pedetes* and *Dipus* is well marked and has the initial *f* curvature as in man. In the fœtal *Pedetes* the shaft was entirely ossified, but the two extremities were cartilaginous.

The *Scapula* has much more the human shape in *Pedetes* than it has in *Dipus*: this is due to the fact that the vertebral border is much longer in comparison in the former animal than in the latter; there is a very faint indication of a metacromion process in both animals. In the fœtus the ala and spine alone were ossified.

The *Humerus* in *Pedetes* is half the length of the femur, there is a fairly prominent pectoral ridge about the middle of the bone, and the inner condyle is very prominent and curved upward into a hook-like process, but there is no bony supracondylar foramen. The external supracondylar ridge is well marked. In the fœtus the shaft alone is ossified; it is interesting to notice that in the cartilaginous lower end of the bone there is a supracondylar foramen.

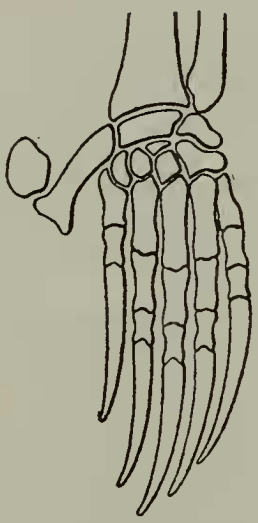
In *Dipus* the humerus is considerably less than half the length of the femur; in appearance it closely resembles that of *Pedetes*, there is the same recurved internal condyle and prominent external supracondylar ridge, but the pectoral ridge is more strongly marked.

The *Radius* and *Ulna* in *Pedetes* are very strong and are shorter in proportion than those of *Dipus*, which, besides being longer, are much more delicate; this contrast is doubtless due to the great amount of digging which *Pedetes* has to perform.

The *Carpus* of *Pedetes* consists of, in the proximal row, scapholunar, cuneiform, and pisiform; in the distal row, trapezium, trapezoid, os magnum, and unciform. In the interval between the scapho-lunar, trapezoid, and os magnum there is a small wedge-shaped centrale, which is only visible on the dorsal side. Articulating with the radial side of the scapho-lunar is the radial ossicle or præpollex: this structure agrees very closely with that figured

and described by Bardeleben[1]: it consists of two joints, of which the proximal is a rod 14 mm. in length, thickened at either end and stretching inwards across the palm; the distal joint is 7 mm. long, flattened from the palmar to the dorsal surface, and broader than the proximal; its long axis is directed outward, so that with the proximal joint it forms an acute angle (see fig. 2, p. 867). The metacarpal bone of the pollex is very short; it is parallel and in the same plane as the other four metacarpals and is not at all opposable (see fig. 1).

Fig. 1.



Dorsal view of carpus of *Pedetes caffer*, with radial ossicle flattened out

In the fœtal specimen no centres of ossification were present in the carpus; in the metacarpus centres were present for the shafts of the index, medius, and annularis, but not for the pollex or minimus. The præpollex or radial ossicle, as perhaps it will be wiser to term it while its real nature is *sub judice*, is a cartilaginous bar corresponding in shape with the adult structure, but no joint between the two segments could be made out; there were no ossific centres. It will thus be seen that the evidence which this fœtal specimen has to give on the radial ossicle is chiefly negative: the structure is apparently a cartilaginous constituent of the carpus from an early period, but how and when it ossifies remains to be seen. It is interesting to notice that the three metacarpals which are most permanent in the mammalian class are the ones which, in this animal, ossify first. If this rule holds good, it could not be expected that the radial ossicle, if it be a præpollex, would ossify until after the minimus and pollex have done so. In *Dipus* there is a single bony bar stretching across the palm and articulating with the radial side of the scapho-lunar; it has the palmaris longus inserted into its free extremity

[1] P. Z. S. 1889, p. 260.

and evidently corresponds to the proximal joint of the same structure in *Pedetes*. No signs of a distal joint are present.

It is worthy of remark that the long axis of the distal joint of the radial ossicle of *Pedetes* is placed at such an angle with that of the proximal that its termination is situated near the root of the nail, while its proximal end is opposite the free edge of the nail. I do not, however, think that this change in the relative position of the parts is of any great importance.

The *Os Innominatum* has the surface for the iliacus directed ventro-laterally, as in the Hares. The ischial tuberosity is very prominent, and the obturator foramen large and pear-shaped. In the fœtal bone only the three primary centres are present.

The *Femur* is chiefly remarkable for the large size of the laterally compressed great trochanter, at the base of which a rudimentary third trochanter exists. There are two fabellæ, of which the outer is the larger. The femur of *Dipus* is practically identical, except that the articular surface of the head is continued outward for a considerable distance on to the upper surface of the neck.

The *Tibia* is considerably longer than the femur, the cnemial crest being specially prominent.

The *Fibula* is transitional between the hystricomorphine type, in which it is a distinct bone, and the myomorphine, in which it is fused with the tibia in its lower part. In *Pedetes* the fibula is quite free in its upper half, and from the front of the head a process projects forward and inward; in its lower half the bone is closely bound to the tibia and becomes so attenuated as to be barely visible; it is, however, at no time completely merged with the tibia. The external malleolus is fairly well marked, and considerable movement is allowed between it and the tibia. In *Dipus* the fibula becomes completely incorporated with the tibia in its lower half, as it is in mouse-like rodents generally, and no movement is possible between the external malleolus and the tibia. In the fœtal specimen of *Pedetes* only the centres for the shafts of these long bones were present.

The *Tarsus* consists as usual of astragalus, calcaneum, navicular, 3 cuneiforms, and cuboid. The navicular is remarkable for having a process on the plantar surface prolonged from before backward and laterally compressed; it projects anteriorly under the external cuneiform and almost touches the base of the middle (3rd) metatarsal; between its anterior projection and the external cuneiform is a tunnel for the peroneus longus tendon. The internal cuneiform is prolonged forward on the inner side of the base of the second metatarsal, into this projection the tendon of the peroneus longus is inserted; hence there is little doubt that it represents the aborted first metatarsal. The internal cuneiform is also prolonged backward along the inner side of the navicular until it just reaches and articulates with the head of the astragalus. On the inner side of the internal cuneiform is a thin plate of bone with its long axis at right angles to that of the foot; its upper extremity articulates with the inner side of the navicular, while its lower

extremity receives the insertion of the tendon of the flexor tibialis. From its position I think that it may correspond with the radial ossicle in the manus, though it is connected with the distal row of tarsals instead of the proximal. A ligament runs forward from the anterior part of its lower extremity and connects it with the dorsal extensor tendon. In *Dipus*, as is well known, the three middle metatarsals are fused, but on the inner and outer side are rudiments of the first and fifth metatarsals, the former being continuous with the internal cuneiform. In the fœtal *Pedetes* there are centres for the calcaneum and for the shafts of the four metatarsals and their phalanges.

The Muscular System.

In former volumes of the Proceedings of this Society [1] I have described the muscles of a considerable number of Rodents. I shall therefore content myself with noticing the chief points in which *Pedetes* agrees with or differs from the typical arrangement.

The *Temporal* is very small and does not meet its fellow in the mid line of the skull.

The *Masseter* has the typical hystricomorphine arrangement; the anterior deep part is very large as in all the Hystricomorpha and Dipodidæ.

The *Facial Muscles* consist of orbicularis palpebrarum, orbicularis oris, levator labii superioris, retractor and depressor naris, depressor anguli oris: there is also a muscle which rises from the malar bone beneath the orbit and deep to the orbicularis palpebrarum; it passes round the chin like a chin-strap, and is inserted into the skin of that region; its fibres are parallel with and in the same plane as those of the sphincter colli, and it is the only representative of the zygomaticus to be found.

The *Depressor Mandibulæ* (Digastric) has the typical sciuromorphine and myomorphine arrangement (figured on p. 255, P. Z. S. 1894), and in this agrees with the Dipodidæ.

The *Transversus Mandibulæ* is absent, but is present in the Dipodidæ.

The *Sterno-mastoid* rises from the presternum and is inserted by tendon into the paroccipital process.

The *Cleido-mastoid* rises from the inner half of the clavicle and is inserted by flesh into the paroccipital process and occipital crest. As in all Rodents the XIth nerve passes deep to both muscles.

The *Sterno-hyoid* and *Sterno-thyroid* are distinct and have the usual human attachments. No tendinous intersection was seen.

The *Omo-hyoid* was absent. It is always present in the Sciuromorpha, Myomorpha, and Dipodidæ.

The *Omo-trachelian* (Levator claviculæ) rises from the anterior arch of the atlas and is inserted into the metacromion deep to the trapezius.

[1] P. Z. S. 1894 and 1896.

Scalene Muscles.—No scalene passes ventral to the subclavian artery and brachial plexus; there is therefore no scalenus ventralis corresponding to the scalenus anticus of human anatomy. In many hystricomorphine and some myomorphine rodents this muscle is present and rises from the basioccipital; it does so in the Dipodidæ, and its absence in *Pedetes* is worthy of notice. The scalenus longus rises from the 2nd, 3rd, and 4th cervical transverse processes and is inserted into the second rib only instead of going to the anterior 4 or 5 ribs. The scalenus brevis is deep to the last: it rises from the 2nd, 3rd, 4th, and 5th cervical transverse processes and is inserted into the first rib.

The *Pectoral muscles* correspond very closely with the description given on p. 259, P. Z. S. 1894. The pectoralis minor (δ) is inserted into the upper part of the pectoral ridge instead of going to the coracoid and shoulder-joint.

The *Subclavius* passes from the junction of the 1st rib with the sternum to the outer half of the clavicle.

The *Scapulo-clavicularis* is absent. This I regard as a most important point, as this muscle was found in all the hystricomorphine rodents examined, but was absent in the Dipodidæ.

The *Deltoid* has the usual three parts, with their characteristic rodent insertion into the humerus. They are all supplied by the circumflex nerve.

The *Teres major* is wrapped round at its insertion by the tendon of the latissimus dorsi as in the Dipodidæ.

The *Flexor longus cubiti* (Biceps) has two heads, in the Dipodidæ there is usually only one. The insertion is into the radius.

The *Coraco-brachialis* rises from the coracoid process and is inserted into the humerus from the middle to the internal condyle, so that apparently the medius and longus are present. In the Dipodidæ the brevis may or may not be present.

The *Flexor Brevis Cubiti* (Brachialis anticus) has the usual external and internal heads, though they are closely fused. The insertion is entirely into the ulna. No branch is received from the musculo-spiral nerve, but there are two from the musculo-cutaneous.

The *Extensor Longus Cubiti* (Triceps) and *Anconeus* show nothing of special interest.

The *Epitrochleo-anconeus* is present as usual.

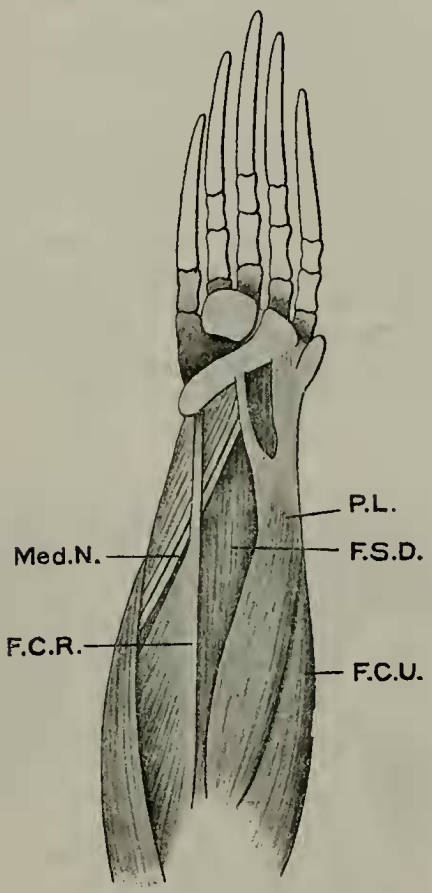
The *Pronator Radii Teres* passes from the supracondylar arch to the middle of the radius.

The *Flexor Carpi Radialis* has the usual attachments, its tendon passes deep to the base of the radial ossicle or prepollex.

The *Palmaris Longus* rises from the internal condyle and from the surface of the flexor sublimis digitorum: in the lower part of the forearm its tendon divides; the inner and broader portion is inserted into the radial ossicle at its most internal part as well as into the ulnar ossicle; the outer and narrower part is attached to the middle of the internal border of the radial ossicle (see fig. 2). In connection with this it is interesting to compare the figure of

the fore foot of *Cœlogenys paca* (P. Z. S. 1894, p. 271): it will there be seen that the palmaris longus is inserted into the distal joint of the radial ossicle or prepollex, which in this animal is cartilaginous, as well as into the ulnar cartilage, which presumably represents the post-minimus, and into another cartilage which is intermediate between the two.

Fig. 2.



Forearm of *Pedetes*.

Med.N. Median nerve.
F.C.R. Flexor carpi radialis.
P.L. Palmaris longus.
F.S.D. Flexor sublimis digitorum.
F.C.U. Flexor carpi ulnaris.

The *Flexor Sublimis Digitorum* runs from the internal condyle to the four inner digits, the tendon to the minimus being very small. It is entirely supplied by the ulnar nerve.

The *Flexor Carpi Ulnaris* is normal and passes to the pisiform bone.

The *Flexor Profundus Digitorum* arises by two heads from the internal condyle of the humerus as well as from the flexor surfaces of the radius and ulna. As the two condylar heads join the radial side of the rest of the muscle about the wrist, they probably

correspond to the condylo-radial and condylo-central elements described by Windle[1]. In the hand a tendon is given off to each of the five digits. The nerve-supply of the muscle is derived entirely from the median.

The *Lumbricales* are four, and are arranged as in man.

The *Pronator Quadratus* is attached to the lower third of the radius and ulna.

The *Supinator Longus* is absent. It is present in the Dipodidæ, but is usually absent in the Hystricomorpha.

The *Extensores Carpi Radiales Longior and Brevior* are normal, the latter being the larger.

The *Extensor Communis Digitorum* goes to the four ulnar digits.

The *Extensor Minimi Digiti* goes to the 5th digit only.

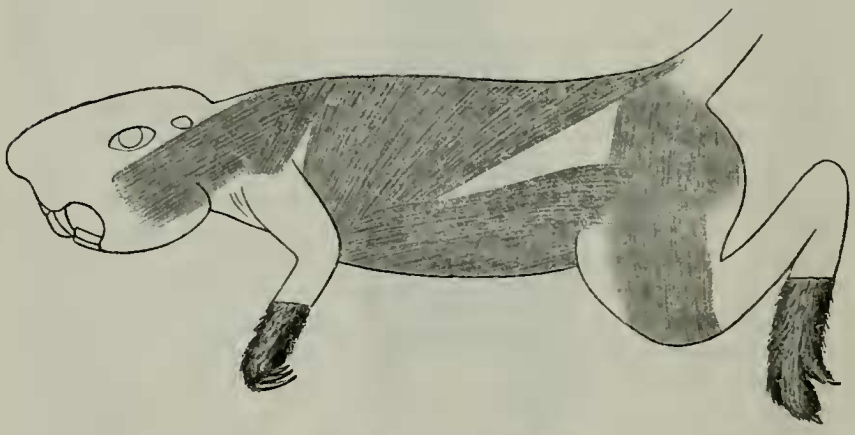
The *Extensor Carpi Ulnaris* and *Extensor Ossis Metacarpi Pollicis* are both normal.

The *Extensores Primi et Secundi Internodii Pollicis* are absent.

The *Extensor Indicis* is small and only goes to the index.

The *Supinator Brevis* is large and is inserted into the upper two-thirds of the radius. A large sesamoid bone which rests against the head of the radius is developed in the tendon.

Fig. 3.



The panniculus of *Pedetes*

Hand-Muscles.—From the ulnar and distal sides of the radial ossicle muscular fibres arise: some run inwards to the ulnar ossicle, forming a palmaris brevis; some run distalward to the skin of the palm, while others again pass to the pollex, forming an indistinct abductor and flexor brevis pollicis. The hypothenar muscles are very feebly marked and indistinct, but an abductor minimi digiti can be made out.

The second layer of hand-muscles consists, as is so often the case, of adductores pollicis, indicis, et minimi digiti.

In the third layer there are two-headed flexores breves to each finger.

Among the *Trunk-Muscles* the *Panniculus carnosus* is remarkable

[1] Journ. of Anat. vol. xxiv. p. 72.

for its great development over the gluteal region and outer part of the thigh (see fig. 3).

The platysma, dorso-humeralis, and abdomino-humeralis are also well marked. The sphincter colli is feeble and does not extend back superficial to the pectoralis at all.

The *Latissimus Dorsi* comes from the last three ribs and lumbar fascia; it hardly reaches the thoracic spines. Its tendon wraps round and is inserted ventral to that of the teres major.

The *Trapezius* in the Dipodidæ is divided into an anterior and posterior part, a distinct gap intervening between them. In *Pedetes* the muscle is quite continuous as in man.

The *Rhomboideus Capitis, Colli et Thoracis* form one continuous sheet as in most hystricomorphine rodents.

The *Levator Anguli Scapulæ* and *Serratus Magnus* rise from all the cervical transverse processes and from the first rib, then there is a gap, after which the origin is continued from the 3rd to the 7th ribs. The first part is inserted into the whole of the vertebral border of the scapula, the second part only into the angle.

The *Serratus Dorsalis* (*S. posticus*) in the Dipodidæ is hardly developed at all. In *Pedetes* both the thoracic and lumbar parts are well marked, the former being attached from the 4th to the 9th ribs, the latter from the 8th to the 12th.

The *Transversalis Colli* is large and attached from the 2nd t the 7th cervical vertebræ.

The *Transversalis Capitis* or *Trachelo-mastoid* is absent.

The *Splenius Capitis* was present as usual; a small *Splenius Colli* was inserted into the transverse process of the atlas only.

The *Complexus* could not be separated into two parts. A linear V-shaped intersection occurred in it, the apex of the V being downwards.

The *External Oblique* rises from the third to the last rib.

The *Internal Oblique* and *Transversalis* were easily separable in the lateral part of the abdominal wall.

The *Rectus ventralis* (Abdominis) rises from the crest of the pubes, but does not decussate with its fellow of the opposite side; it is continued forward to the first rib, and there are five tendinous intersections in its course.

The *Supracostalis* is well marked; it rises from the sternum, opposite the attachment of the first two rib-cartilages, by a membranous origin and is inserted into the first rib opposite the insertion of the scalenus. It is, of course, superficial to the rectus ventralis and deep to the pectorals.

The *Ilio-tibialis* (*Sartorius*) runs from Poupart's ligament to near the patella, where it is lost in the fascia; it is supplied by the anterior crural nerve.

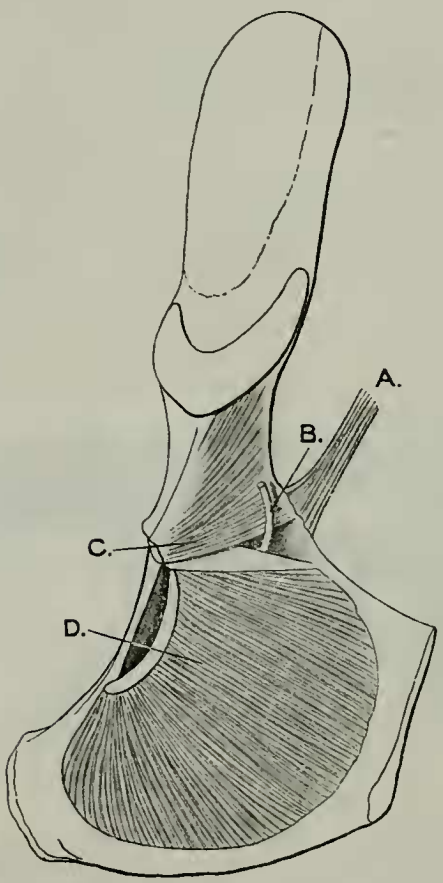
The *Tensor Fasciæ Femoris* continues the plane of the last muscle outward; it reaches the lower third of the thigh.

The *Ectogluteus* continues the plane of the last and has the typical mammalian characteristics; it is inserted just below the great trochanter. Externally it is continuous with the *Caudo-*

femoralis or *Agitator caudæ*, a large muscle inserted into the lower end of the femur by tendon and reminding one of the same muscle in the Guinea-pig figured on p. 737 of the 'Journal of Anatomy,' vol. xxxii.

The *Meso-gluteus* rises from the anterior part of the gluteal surface of the ilium and from the margin of the sacrum dorsal to the great sciatic notch. It is closely connected with the *Pyriformis*, and is inserted into the outer side of the great trochanter.

Fig. 4.



Inner view of wall of pelvis of *Pedetes*.

C. & D. Upper and lower portions of the obturator internus.
B. Obturator nerve.
A. Psoas parvus.

The *Ento-gluteus* rises from the ilium dorsal to the last and is inserted into the anterior surface of the great tochanter.

The *Gluteus ventralis* (*Scansorius*) rises behind and ventral to the last and is iuserted into a tubercle below the outer side of the great trochanter.

The *Obturator Externus*, *Obturator Internus*, and *Gemelli* are all inserted into the digital fossa. The obturator internus is divided

into two by the obturator nerve (see fig. 4). The gemelli are fused and form one layer deep to the obturator internus tendon.

The *Quadratus Femoris* is triangular, with its apex towards the great trochanter.

The *Flexor Cruris Lateralis* (*Biceps*) has only one head, which comes from the tuber ischii. It is inserted into the patella and upper half of the leg. There is no *Tenuissimus* and no continuation of its lower fibres down with the tendo Achillis.

The *Semitendinosus* rises by two heads from the tuber ischii and from the anterior caudal vertebræ, but there is no tendinous intersection where these join. It is inserted deep to the gracilis, the lower fibres forming a fascia which helps to ensheath the tendo Achillis and to blend with it.

The *Semimembranosus* rises only from the tuber ischii. It is inserted into the lower end of the femur just above the internal condyle, into the postero-internal part of the capsule of the knee-joint, and into the internal tuberosity of the tibia by one continuous insertion. There is no presemimembranosus distinct from this, and I regard *Pedetes* as an animal in which the semimembranosus and presemimembranosus are inseparable from origin to insertion.

The *Adductor Cruris* (*Gracilis*) is single and is inserted into the cnemial crest and upper third of the anterior border of the tibia. It does not reach so high as the patella. In the greater number of hystricomorphine and myomorphine rodents there are two adductores cruris.

The *Pectineus* is a small muscle rising from the ilio-pectineal line just internal to the insertion of the psoas parvus and being inserted into the second quarter of the femur. It is supplied entirely by the obturator nerve.

The *Adductor anticus* (*Adductor longus*) is that part of the adductor mass which lies ventral to the obturator nerve and is indicated by the point of emergence of the branch to the adductor cruris. It arises from the inner part of the ilio-pectineal line and is inserted into the middle two-fourths of the femur.

The rest of the *Adductor mass* (*Adductores medius et posticus*) rises from both rami of the pubes, from the symphysis, and from the ramus and tuberosity of the ischium. It is inserted into the middle two-fourths of the femur.

The *Quadriceps Extensor Cruris* has the usual four heads. The *Superficialis quadricipitis* (*Rectus Femoris*) has only one head, which probably corresponds to both the straight and reflected heads of human anatomy.

The *Lateralis quadricipitis* (*Vastus externus*) is much larger than the *mesialis* (*V. internus*). The *Profundus quadicipitis* (*Crureus*) rises from the whole length of the shaft of the femur.

The *Tibialis Anticus* has no femoral origin. It rises from the upper third of the tibia and is inserted into the rudimentary first metatarsal.

The *Extensor Longus Digitorum* rises as usual from the external condyle of the femur: it divides into a superficial and deep layer;

the former runs to the index and medius, the latter to all four digits.

There is no trace of an *Extensor Proprius Hallucis*.

The four *Peroneal Muscles* (*longus*, *brevis*, *quarti digiti*, and *quinti digiti*) have the attachments usually found in hystricomorphine rodents.

The outer head of the *Gastrocnemius* rises from the external condyle and outer side of the patella; a large fabella is developed in it. The inner head only comes from the condyle and has a smaller fabella.

The *Plantaris* rises from the external fabella; it is large and fleshy in the calf; its tendon with that of the gastrocnemius forms the usual rope-like twisting described in the 'Journal of Anatomy' (vol. xxviii. p. 414). In the sole there is no muscular belly representing the flexor brevis digitorum, but tendons pass to form flexores perforati to all four digits, though the outermost is very small.

The *Soleus* rises from the outer side of the head of the fibula; it joins the tendo Achillis just above the ankle.

The *Popliteus* is normal.

The *Flexor Tibialis* (*Flexor longus digitorum*) rises from the second quarter of the posterior surface of the tibia, below the popliteus. It is inserted into the tibial ossicle (see fig. 7, p. 877).

The *Flexor Fibularis* (*Flexor longus hallucis*) rises from the upper half of the back of the tibia and fibula and sends tendons (flexores perforantes) to all four toes.

It will thus be seen that in *Pedetes* the flexor tibialis fails to join the flexor fibularis in the sole. This is a marked contrast to the arrangement in the Dipodidæ and also to that of most of the Hystricomorpha.

The *Tibialis Posticus* and *Accessorius* are absent.

The two middle *Lumbricales* are present.

Of the deep muscles of the foot the first layer consists of an *adductor indicis* and of an *adductor minimi digiti*. The second layer contains four double-headed *flexores breves*. The third layer is represented by one dorsal interosseous muscle between the index and medius; it is inserted into the dorsal expansion of the medius.

In contrasting the myology of *Pedetes* with my former work on the muscles of other Rodents, it is evident that this animal, like the Dipodidæ, occupies a position between the Hystricomorpha and Myomorpha. The most important Hystricomorphine characteristics are:—

1. The large anterior deep part of the masseter passing through the infraorbital foramen: this is always found in the Hystricomorpha and never, so far as I know, in the Myomorpha except in a very rudimentary condition.
2. The absence of the transversus mandibulæ, which is always present in the Myomorpha.
3. The absence of the omo-hyoid. It is true that this muscle is

not always absent in the Hystricomorpha, but it is always present in the Myomorpha.

4. The presence of a splenius colli. This is not a very important point, but I have never yet found the muscle among the Myomorpha.

The most important Myomorphine characteristics are :—

1. The arrangement of the depressor mandibulæ (digastric). This has the tendinous arcade and fused anterior bellies so characteristic of myomorphine and sciuromorphine rodents.
2. The absence of a scalenus ventralis. This muscle is not always present in the Hystricomorpha, but it is always absent in the Myomorpha.
3. The absence of a claviculo-scapularis, a muscle which was always found in the Hystricomorpha but never in the Myomorpha.
4. The flexor tibialis does not unite with the flexor fibularis in the sole as it usually does in the Hystricomorpha. Dobson made a great point of the value of these tendons for classificatory purposes, but I have met with evidence to show that it is not altogether reliable.
5. The biceps cubiti (flexor longus cubiti) has two heads : this arrangement is almost invariable among the Myomorpha, but it also sometimes occurs in the Hystricomorpha.

With regard to the relationship of *Pedetes* with the Dipodidæ, the following resemblances are important and suggestive :—

1. There is a tendinous arcade in the digastric and the anterior bellies are in contact.
2. There is no claviculo-scapularis.
3. The origin of the omo-trachelian (levator claviculæ) is from the atlas.
4. The rectus ventralis does not decussate with its fellow in front of the pubic arch.

The following, on the other hand, are points in which *Pedetes* differs from the Dipodidæ :—

1. The scalenus ventralis (anticus) does not rise from the basi-occipital bone.
2. There are two heads to the biceps cubiti (flexor longus cubiti).
3. There is no transversus mandibulæ.
4. There is no omo-hyoid.
5. The splenius colli is present.
6. The flexor tibialis does not join the flexor fibularis in the sole.

I am of opinion that a careful comparison of the muscles of *Pedetes* with those of other Rodents shows that it is allied

to the Dipodidæ, but that it occupies a position between them and the Hystricomorphine Rodents; and, if it is desirable for practical purposes to arbitrarily draw a sharp line between the Hystricomorpha and Myomorpha, *Pedetes* would fall on the hystricomorphine side and the Dipodidæ on the myomorphine.[1]

Ligamentous System.

The *Temporo-maxillary joint* has a well-marked lax meniscus; when the condyle glides forward and backward the meniscus accompanies it, but the hinge-like movements of opening and closing the mouth take place between the condyle and the meniscus.

The *Sterno-clavicular joint* is formed by the inner end of the clavicle, which is bevelled at the expense of its ventral surface so as to slide dorsal to the manubrium sterni. This inner part of the clavicle is cartilaginous and is fastened to the sternum by fibrous tissue.

Acromio-clavicular joint.—The acromion is united to the clavicle by fibro-cartilage and there is no joint cavity here.

The *Coraco-clavicular ligament* is well marked and runs from the dorsal border of the clavicle to the coracoid.

The *Shoulder-joint* has a lax capsule without any openings, except that for the biceps tendon, or any appreciable thickenings. Both coraco- and gleno-humeral ligaments were looked for, but no trace of them was seen.

The *Elbow* is chiefly remarkable for a well-marked crescentic sesamoid bone in the orbicular ligament; it is attached to the external condyle by the external lateral ligament and gives origin to the supinator brevis; it articulates with the radius and the humerus, and between it and the olecranon there is a pad of fat. Pronation through $\frac{1}{3}$ of a circle is allowed at this joint when the muscles are removed.

The interosseous membrane between the radius and ulna is very strong; above most of the fibres run from the ulna downward and outward to the radius, below they mostly have the opposite direction. There is no synovial cavity between the lower end of the ulna and radius, but the triangular fibro-cartilage is continuous with the interosseous membrane.

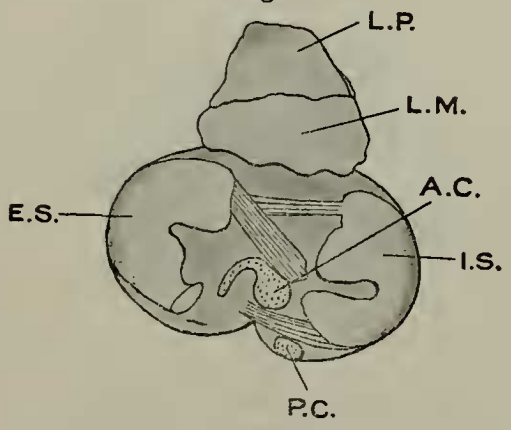
Wrist-joint.—The styloid process of the ulna is large and rounded, and fits into a concavity formed by the cuneiform and pisiform bones. The anterior ligament of the wrist contains ulno-carpal and radio-carpal bands, which both run to the great scapho-lunar bone. The prepollex articulates with the radial extremity of the scapho-lunar (see fig. 1, p. 863), and there is a well-marked

[1] Since writing the above I have re-read a paper by Mr. Oldfield Thomas on the "Genera of Rodents," P. Z. S. 1896, p. 1012, and am pleased to find that his views on the position of *Pedetes*, founded on a study of the skull and teeth, agree exactly with my own. I hope soon to be able to compare the muscles of *Anomalurus* with those of *Pedetes*.

synovial cavity which communicates with the main cavity of the carpus. The distal segment of the radial ossicle is connected with the proximal by means of ligaments, but there is, as far as I can make out after careful examination, no synovial cavity.

Hip-joint.—The capsule is not specially thickened at any one place; it is attached all round the acetabulum and to the transverse ligament ventro-caudally; externally it thins suddenly before its attachment to the junction of the neck and shaft, so that the margin of the thick part forms a sphincter round the neck of the femur. The cotyloid ligament is much broader in proportion than in man and keeps the head of the femur in position, so that a good deal of force is required to release it. Over the cotyloid notch, where it is just as broad as elsewhere, it forms the transverse ligament. The ligamentum teres consists of a narrow ribbon-like band of fibrous tissue contained in a sheath of synovial membrane. The fibrous tissue is continued through the cotyloid notch and under the transverse ligament to the dorsal part of the capsule; it checks no movement of which the joint is capable, but, in extreme flexion, tenses some of the dorsal part of the capsule. The Haversian pad of fat is present and well marked.

Fig. 5.



Knee-joint of *Pedetes* with the femur removed.

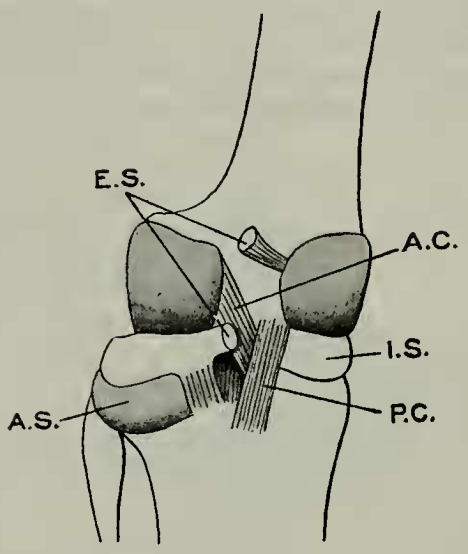
L.P. Ligamentum patella.
L.M. Ligamentum mucosum.
E.S. & I.S. External and internal semilunar cartilages.
A.C. & P.C. Anterior and posterior crucial ligaments.

The Knee-joint.—On opening the joint from the front the synovial membrane is seen to be continued up for about $\frac{1}{4}$ inch above the upper limit of the trochlear surface. The origins of the extensor longus digitorum and popliteus are both within the synovial cavity. The external lateral ligament runs downward and very much backward to the head of the fibula. The internal lateral ligament is not prolonged so far down the tibia as it is in many mammals; it passes from the internal condyle downward and forward, to the head of the tibia $\frac{1}{4}$ in. below the level of the joint.

The posterior ligament consists only of vertical fibres which are pierced by the large azygos artery.

Laterally, behind the condyle on each side, the joint cavity communicates with a bursa under the respective heads of the gastrocnemius, while in each head of the gastrocnemius there is a fabella. The two crucial ligaments have the human attachments, but they are not connected together at all. The synovial membrane of the ligamentum mucosum is continued back to the crucial ligaments, so that it is impossible to pass a probe between the ligamentum mucosum and the anterior crucial ligament as in man. The semilunar cartilages are remarkable for having their anterior parts ossified; this is interesting when it is compared with the condition of the orbicular ligament in the elbow, though, as has already been pointed out, the animal was a fully adult, if

Fig. 6.



Knee-joint of *Pedetes* from behind.

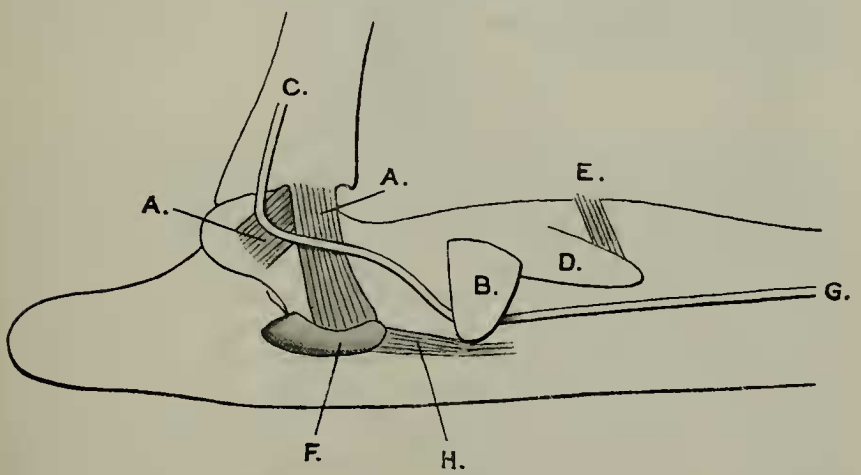
A.C. & P.C. Anterior and posterior crucial ligaments.
E.S. & I.S. External and internal semilunar cartilages.
A.S. Articular surface over which popliteus plays.

not an aged specimen. The posterior attachment of the external cartilage runs upward and inward, to be attached to the back of the internal condyle; it lies in a plane posterior to that of the posterior crucial ligament and evidently corresponds to the oblique ligament of Humphry of human anatomy (see fig. 6). The posterior part of the external coronary ligament is the only part present, but the internal semilunar cartilage has more or less of a coronary ligament all round. The two cartilages are connected to the lateral ligaments by loose connective tissue, so that they can move independently of these. In extension of the joint there is a considerable portion of the articular surface of the external tuberosity of the tibia behind

the external semilunar cartilage; over this the popliteus tendon glides (see fig. 6, A.S.).

The Ankle-joint.—A strong ligament runs from the front of the lower extremity of the tibia, just at the upper attachment of the anterior ligament of the ankle, forward to join the expansion of the extensor longus digitorum on the inner side of the medius digit and opposite the metatarso-phalangeal joint. The anterior ligament of the ankle is very feeble and has a layer of fat between it and the synovial membrane. The posterior ligament is practically absent. The external lateral ligament consists of three bands: the most superficial runs from the tibia at the posterior margin for the groove of the peroneals to the upper margin of the outer surface of the calcaneum just below the tip of the external malleolus. A second ligament runs downward and backward, from the anterior border and tip of the external malleolus, crossing deeply to the last ligament and being attached to the calcaneum just behind it. A third ligament runs from the back of the external malleolus to the outer side of the

Fig. 7.



Inner view of ankle and foot of *Pedetes*.

A. Internal lateral ligament.
B. Tibial ossicle.
C. Flexor tibialis tendon.
D. Rudimentary 1st metatarsal.
E. Tibialis anticus tendon.
F. Sustentaculum tali.
G. Ligament running forward to dorsum of toe.
H. Calcaneo-navicular ligament.

astragalus. It will be noticed that the last-named two bands correspond to the middle and posterior fasciculi of the human external lateral ligament, but that the anterior fasciculus of that ligament is absent. The internal lateral ligament consists of two bands, superficial and deep; the superficial runs downward and forward from the internal malleolus to the sustentaculum tali; the deep band is shorter and runs from the same place downward and backward to the inner side of the astragalus.

Tarsal joints.—The astragalus is bound to the calcaneum by dorsal and interosseous ligaments; they are both very strong, and the latter runs from the plantar surface of the head of the astragalus to the anterior part of the dorsal surface of the calcaneum.

Dorsal ligaments between the other tarsal bones are present but are not worthy of special mention. The calcaneo-navicular ligament is strong and consists of two layers of fibres; the plantar run antero-posteriorly and the dorsal transversely. The long calcaneo-cuboid ligament is well marked and runs forward chiefly into the origins of the deep muscles of the sole; beneath the bases of the 4th and 5th metatarsals there is a sesamoid bone in this ligament. The short calcaneo-cuboid ligament lies deep to the last and is entirely concealed by it; it is well marked and runs from bone to bone.

The *Tarso-metatarsal joints* have dorsal and plantar ligaments.

The *Metatarso-phalangeal* joints have two sesamoid bones developed in the plantar ligament; these bones are firmly connected with the phalanx, but very loosely with the metatarsal bone, so that they can glide over the head of the latter; lateral ligaments connect the metatarsal bone with the phalanx and each of these with the sesamoid bone.

Digestive System.

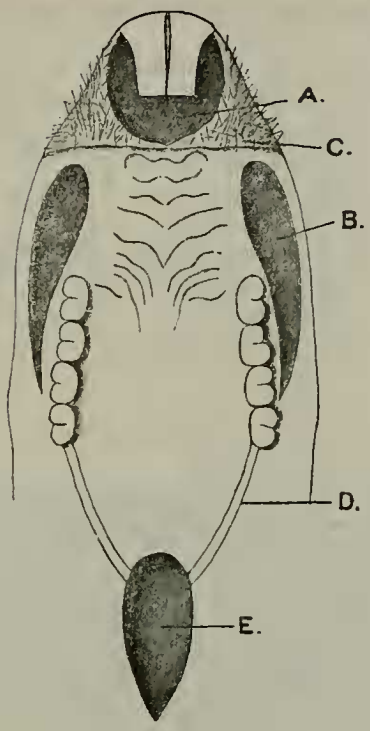
The Palate.—Just behind the upper incisor teeth is a well-marked fossa $\frac{1}{8}$ inch deep (A, fig. 8, p. 879); behind this are two triangular patches of fur, the apices of which meet in the middle line (C, fig. 8). Behind these, on each side, there is an elongated piriform fossa which projects backward on the outer side of the molar teeth, lying between these and the zygoma (B, fig. 8). The anterior part of this fossa is the broader and is $\frac{1}{8}$ inch deep. Posteriorly it tails off and becomes shallower. The hard palate is raised into nine transverse ridges on each side; the hindermost of these is opposite the premolar tooth. The anterior five of these ridges meet their fellows in the mid line. The posterior four fail to do so. The hinder part of the hard palate is smooth. The soft palate and the pillars of the fauces form a piriform opening of small size, through which the naso-pharynx communicates with the bucco-pharynx.

The *Tongue* is remarkable for the presence of a large number of filiform papillæ on its posterior third; they are long and quite hide the circumvallate papillæ. The foliate papillæ are feebly marked, and consist of fourteen short parallel slits on each side without any definite oval ring enclosing them.

The *Stomach* is almost human in shape, except that the part corresponding to the greater cul-de-sac is ill-developed. The greater curvature measured $6\frac{1}{2}$ inches, the lesser $1\frac{1}{2}$ (see fig. 9).

The *Duodenum* forms, as usual, a large free loop; it is 11 inches long. The rest of the *small intestine* measures 6 feet 5 inches, making a total of 7 feet 4 inches from the pylorus to the ileo-

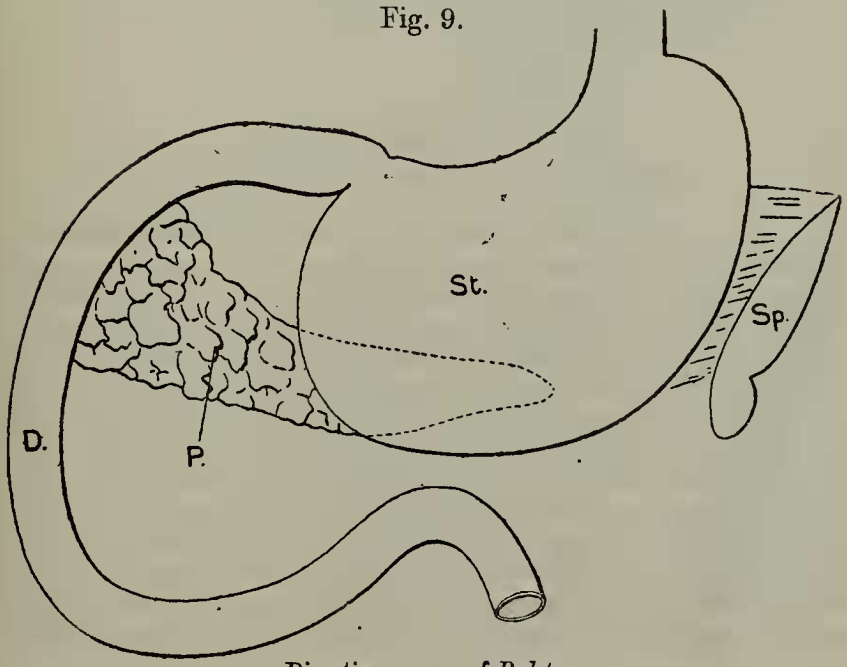
Fig. 8.



Palate of *Pedetes*.

A. & B. Fossæ.
C. Patch of fur.
D. Cut edge of soft palate.
E. Posterior opening of nares.

Fig. 9.

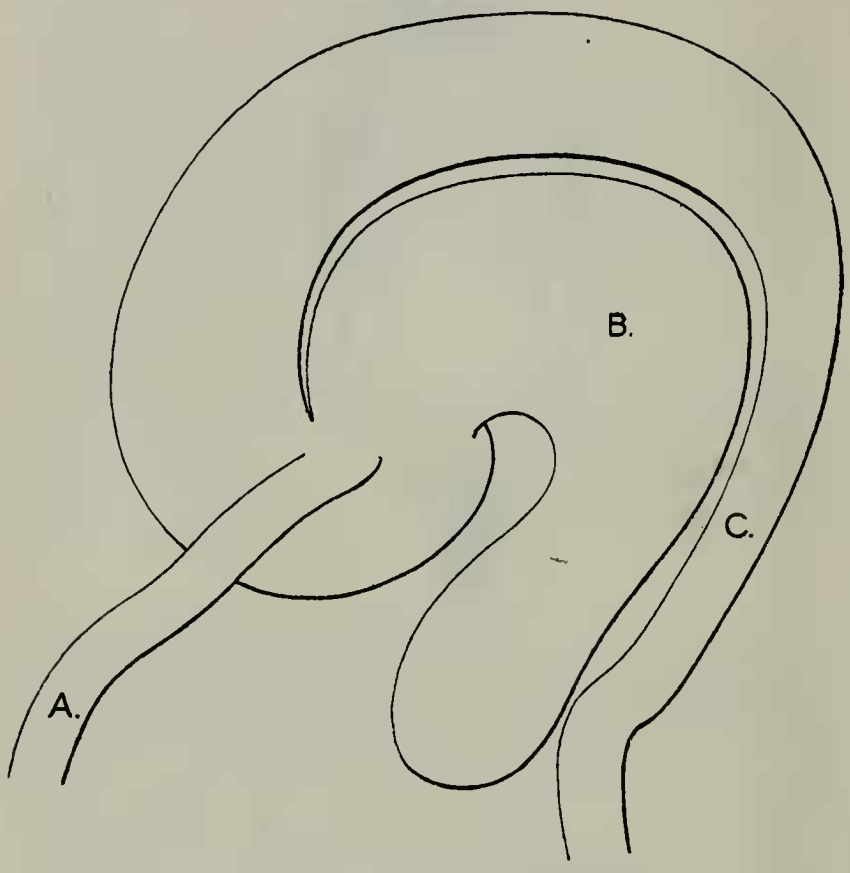


Digestive organs of *Pedetes*.

D. Duodenum.
P. Pancreas.
St. Stomach.
Sp. Spleen.

cæcal valve. The ileum opens into the cæcum on its posterior surface, but there is no sacculus rotundus (see fig. 10).

Fig. 10.



Cæcum of *Pedetes* viewed from behind.

A. Ileum. B. Cæcum. C. Colon.

The *Cæcum* is a thin-walled sac of large calibre, 8 inches in length. It is bent into a horseshoe loop, and round the convexity of the horseshoe the colon lies, the two viscera being bound together by areolar tissue and having no peritoneum between them. The cæcum ends bluntly, and there is no appendix. When the cæcum is opened the ileo-cæcal orifice is seen; this is a transverse slit $\frac{1}{4}$ inch long, capable, when fully distended, of admitting a quill-pen. The valve which guards this opening has, as usual, two lips, cæcal and colic. The cæcal lip is the more prominent, and is prolonged halfway round the gut as a shelf; the colic lip does not extend so far. The mucous membrane of the cæcum has a number of transverse rugæ; these are best marked opposite the posterior part where the vessels enter and the peritoneal attachment is. The *Colon* is at first dilated,

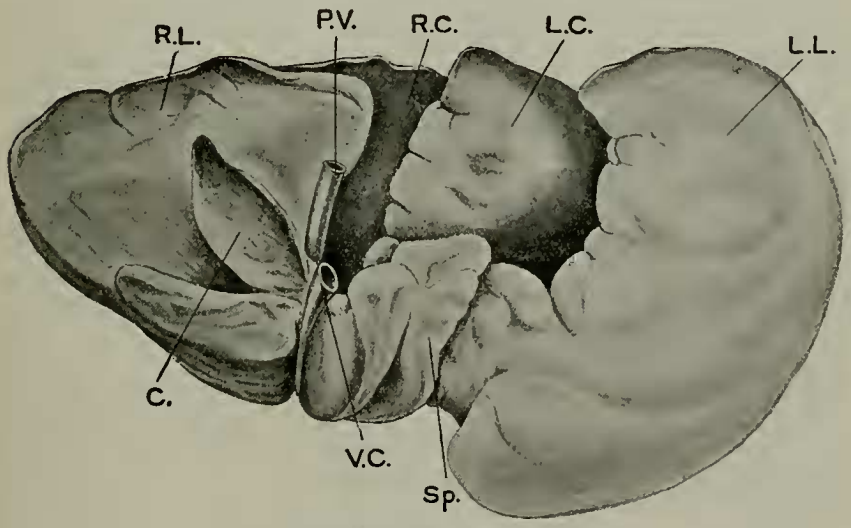
but rapidly narrows, and 7 inches from the valve attains its normal calibre. It measures 3 feet 10 inches from the valve to the anus.

The alimentary canal of the fœtus corresponds very accurately with that of its mother; the cæcum has the same arrangement. No Meckel's diverticulum was seen in the ileum.

The *Pancreas* is a fleshy tongue-shaped gland, about 3 inches long, lying in the concavity of the duodenum; its duct enters the latter about 3 inches from the pylorus (see fig. 9).

The *Spleen* is relatively very small; it measures $1\frac{3}{4}$ inches in its long diameter, and is remarkable for having a notch on its posterior border (see fig. 9). In the fœtus it was comparatively much longer and was triangular in section; no notches were present.

Fig. 11.



Under surface of liver of *Pedetes*.

R.L. Right lateral lobe.	C. Caudate lobe.
R.C. Right central lobe.	Sp. Spigelian lobe.
L.C. Left central lobe.	P.V. Portal vein.
L.L. Left lateral lobe.	V.C. Vena cava.

The *Liver* contains the six typical lobes—right and left central, right and left lateral, spigelian, and caudate. Of these the left lateral is much the largest, and the caudate has the characteristic leaf-like shape. In the fœtus the lobulation is identical, but neither in it nor in the adult specimen is there any gall-bladder.

On comparing the digestive system of *Dipus* with that of *Pedetes*, it was noticed that the depressions behind the incisor and on the outer sides of the molar teeth are wanting, while the ridges on the hard palate extend back as far as the last molar tooth. There are, however, the same two triangular patches of fur, meeting by their apices behind the upper incisors. In the stomach the great cul-de-sac is better developed than it is in

Pedetes. The cæcum is 4 inches long in *Dipus jaculus*; it has a much larger calibre than either intestine, but is not characteristically coiled; it is sacculated, and has a fold of peritoneum, about $\frac{1}{8}$ inch wide, running along one margin and ending in a free border containing vessels. In the liver of *Dipus jaculus* the right central and right lateral lobes apparently were fused into one large one; the caudate lobe was large, and resembled that of the Rabbit in shape and relations. In *Dipus hirtipes* the right lateral lobe was distinct, though small, and was closely pressed against the caudate, so that the two lobes together made a concavity for the anterior part of the right kidney. The gall-bladder was well marked in both species of *Dipus*.

Respiratory System.

The *Larynx* shows little worthy of special mention; the arytenoids, as is usual in Rodents, lie at the sides of the larynx. There are no false vocal cords, but the true ones are well marked. The epiglottis is remarkable for a very prominent cushion. The *Trachea* is $1\frac{1}{2}$ inches long, and has 18 rings before its bifurcation. Opposite the 6th ring, *i. e.* $\frac{1}{2}$ inch from the cricoid, a median septum commences, and after this the trachea is a double-barrelled tube. The septum at first consists merely of mucous membrane, and has a concave free edge towards the larynx; lower down cartilaginous rings are continued into it, and these eventually become double. In the fœtal specimen the same septum was noticed; it reached as far forward as the 3rd ring (there were 16 rings altogether). The right lung has four lobes, of which one is the azygos. The left lung has three. There is an eparterial bronchus on the right side.

In the respiratory system *Dipus* has no septum in its trachea; the right lung has four lobes, as in *Pedetes*, but the left only had a single lobe in *Dipus jaculus* and *hirtipes*.

Urino-Genital System.

The *Kidneys* are compact spheroidal bodies and are very nearly on the same level; the right renal artery is, however, rather more anterior (cephalic) than the left. On section one large median papilla is seen opening into the pelvis renalis, and when this is turned aside two smaller ones are found in front and behind it; there is also a small one above and below, making seven in all.

The *Adrenals* are described with the vascular system.

The *Bladder* was contracted in this specimen, it measured $1\frac{1}{2}$ inches in its longest diameter; the ureters open at the junction of the anterior $\frac{2}{3}$ with the posterior $\frac{1}{3}$ of the dorso-lateral aspect.

The *Urethra* is $1\frac{3}{4}$ inches long, and opens into the vagina $\frac{1}{4}$ inch from the vulval orifice.

The *Uterus* is bicornuate, and the fœtus was situated in the right cornu, the placenta being attached to the antero-external part, close to the opening of the Fallopian tube. The left cornu was normal and was 1 inch long. The cervix uteri projects into

the vagina for $\frac{1}{2}$ inch, and on the dorsal side of its extremity are two external ora.

The *Vagina* is 3 inches in length, and is marked by prominent longitudinal rugæ.

The *Fallopian Tubes* differ on the two sides, that on the right (the pregnant side) is $1\frac{1}{2}$ inches, while the left only measures $\frac{1}{4}$ inch.

The *Ovaries* are situated in a peritoneal pouch corresponding to the arrangement figured by Robinson [1] in the Porcupine. The right one is $\frac{1}{4}$ inch long, fusiform and smooth; the left one is larger and more spherical.

The *Placenta*, when the membranes were opened, was seen to be a thick disc 2 inches long by $1\frac{1}{2}$ broad; its uterine surface was convex and smooth, its fœtal surface concave and lobulated. The umbilical cord was 5 inches long and was attached to the fœtal surface on one side of the middle.

The *Mammary Gland* is very large and occupies the whole of the pectoral region as well as a good deal of the lateral wall of the thorax; ventrally it reaches the mid line, dorsally it extends rather beyond a line drawn horizontally backward from the dorsal fold of the axilla. Anteriorly it reaches to within $\frac{1}{2}$ inch from the clavicle, while posteriorly its edge corresponds to the costal margins. As has been already stated, there are two nipples on each side.

The *Fœtus* was 7 inches long from the snout to the root of the tail, the tail itself being another 3 inches. The head was flexed on the ventral surface of the thorax, and the fore limbs tucked in under the chin. All the joints of the hind limb were strongly flexed, the ankles being close together and the feet crossing so that the right was the more superficial. The tail was coiled up on the right of the right thigh and leg. The eyelids were closed, but could be opened by a little traction. The auricles differed in position on the two sides; that on the right was folded back over the neck, reaching as far as the mid-dorsal line, while the left was turned down and partly covered the eye. The skin was devoid of hair, but the vibrissæ on the side of the snout were numerous and about $\frac{1}{4}$ inch long; there were also five or six shorter bristles above each eye, and three on each side growing from a small flat papilla on the side of the face, dorsad and caudad of the eye. The claws were indicated, but were not yet hardened. The fœtus was of the male sex, and the genital aperture was situated on the summit of a well-marked eminence; at first sight there appeared to be two genital openings, but the more caudal was a blind pouch. The anus was a transverse, slightly crescentic slit.

When the skin was removed the eminence was seen to be caused by the penis, which formed a **U**-shaped curve on the abdomen, the convexity of the **U** being forward, and also by the scrotal sacs, which already contained the testes.

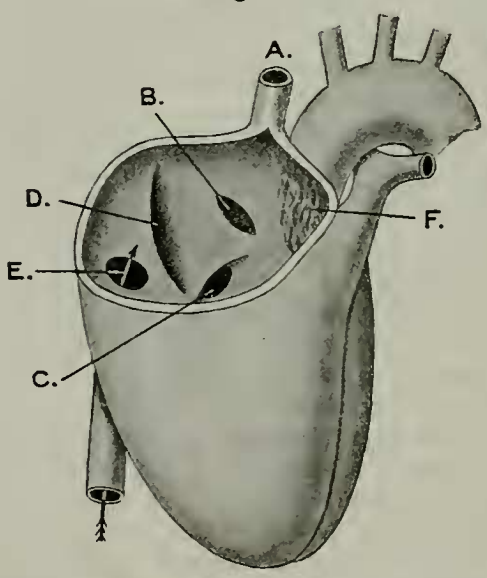
[1] "On the Position and Peritoneal Relations of the Mammalian Ovary," Journ. of Anat. & Phys. 1887.

In *Dipus* the *uterus* resembles that of *Pedetes*, the Fallopian tubes are very short, and the cervix uteri has two ora on its dorsal aspect. The urethra is very long, so that the bladder is an abdominal organ; it opens, however, just beneath the clitoris, at the vulval orifice.

Vascular System.

The *Heart* shows nothing to attract special attention in the ventricles. There is no moderator band in the right. The right auricle shows a well-marked, nearly vertical ridge on the posterior wall (D, fig. 12), lying between the posterior (E) and left anterior (C) caval orifices. It is described by Marshall in the Rabbit as the Eustachian valve ('Practical Zoology,' p. 333), but it is on the wrong side of the postcaval opening to correspond with that structure in man. Its position seems to me to correspond most closely with that of the septum spurium of His. The foramen ovale (B) is patent, and opens into the left auricle by a valvular slit-like opening, exactly as it does when it is patent in man. Two pulmonary veins open into the left auricle on each side.

Fig. 12.



Heart of *Pedetes* with right auricle opened from in front.

A. Right anterior vena cava.	D. Ridge.
B. Foramen ovale.	E. Posterior vena cava.
C. Left anterior vena cava.	F. Appendage with musculi pectinati.

The branches of the arch of the aorta are, as in man, innominate, left carotid, and left subclavian.

In the fœtal specimen the foramen ovale is large, the Eustachian valve is attached to the ventral side of the postcaval orifice. The ridge which has been described in the adult heart is distinct from the Eustachian valve, and is best marked on the ventral

(right) margin of the right precaval orifice. The musculi pectinati converge to it.

The *Innominate artery* divides at the right sterno-clavicular articulation into carotid and subclavian; the former runs along the side of the trachea, and at the anterior border of the larynx divides into external and internal carotids.

The *Subcluvian artery* gives off the vertebral just before the vagus crosses it; more externally it gives off a transversalis colli to the side of the neck, and an internal mammary round which the phrenic nerve loops as it does in man.

The *Axillary artery* divides into two branches of nearly equal size: one of these supplies the axilla, the other goes on as the brachial; the former divides into a ventral branch, which accompanies the internal anterior thoracic nerve to the pectorals and panniculus, and a dorsal branch, which supplies the dorsal part of the axilla, crosses dorsal to the brachial artery and nerves, and passes through the quadrilateral space at the upper part of the arm to join the circumflex nerve: it will thus be seen that the termination of this artery corresponds to the posterior circumflex of human anatomy.

The *Brachial artery* crosses ventral to the inner cord of the plexus, and runs down the arm between the median and ulnar nerves. About the middle of the arm it gives off a superior profunda branch, which accompanies the musculo-spiral nerve to the back. A little above the elbow an external branch is given off which runs superficially to the skin of the outer side of the forearm, while opposite the origin of this is an internal branch which is probably the anastomotica magna. After this the brachial artery passes through the fibrous supracondylar foramen with the median nerve, and at the bend of the elbow gives off a small ulnar branch, which, however, ends in the muscles of the forearm. The main artery now divides into a common interosseous, supplying the deep parts of the front and back of the forearm, and the median artery, which accompanies the nerve of the same name into the hand.

The *Thoracic* and *Abdominal Aortæ* give off the same branches as in the Rabbit. The aorta bifurcates opposite the 6th lumbar vertebra, the caudal artery being given off from the dorsal surface of it, about $\frac{1}{4}$ inch before the bifurcation. The *Common Iliac* arteries bifurcate into external and internal iliacs, close to the inner border of the tendon of the psoas parvus.

The *Internal Iliac* runs backward along the dorsum of the pelvis for some little distance; it then gives off a vesico-hæmorrhoidal branch, which divides to supply the bladder, uterus, and rectum, and a gluteal branch, which escapes from the pelvis through the great sciatic notch. The point where the gluteal branch comes off I regard as the division between the anterior and posterior, or rather ventral and dorsal, trunks of the internal iliac (see "6th Collective Investigation Report of the Anatomical Society of Gt. Britain and Ireland," Journal of Anatomy, vol. xxx. p. 31).

The ventral trunk of the internal iliac runs backward in the pelvis and soon gives off the sciatic artery; some little distance beyond this it divides into its two terminal branches, the obturator and internal pudic.

The *External Iliac Artery* runs along the brim of the true pelvis to the middle of Poupart's ligament, where it becomes the *Femoral*; this, almost at once, gives off a big branch (*Internal Circumflex*), which sinks into the substance of the thigh, passing round the inner side of the head of the femur. Nearly opposite the origin of this another branch (*External Circumflex*) runs outward and divides into a superficial and deep division, while almost at the same point another artery (*Profunda femoris*) passes backward and breaks up to supply almost all the muscles of the thigh. The continuation of the femoral artery which is now the *Superficial Femoral* runs downward as far as the middle of the inner side of the thigh, where it divides into *Popliteal* and *Internal Saphenous*. The former, which is the larger, runs to the popliteal space; the latter passes superficially across the gracilis (*Adductor cruris*) and reaches the inner side of the leg just behind the inner border of the tibia; it then passes down behind the internal malleolus to the sole of the foot, where it forms a plantar arch superficial to the plantar tendons. From this arch branches are given off to the 2nd and 3rd, and 3rd and 4th digits. At the posterior part of the sole of the foot a small external plantar artery is given off, which accompanies the nerve of the same name and supplies the deep muscles of the sole as well as the 5th digit. The *Popliteal Artery*, after giving off articular branches to the knee-joint, divides into anterior and posterior tibial at the upper border of the popliteus muscle. The *Posterior Tibial* is a small artery which ends in the muscles of the calf. The *Anterior Tibial* passes in front of the popliteus, pierces the interosseous membrane, and supplies the muscles in front of the leg, a very small branch continuing on to the dorsum of the foot.

The Venous System.—The veins were examined, but nothing special was noticed. There are, as has been mentioned, two anterior venæ cavæ.

The *Thymus* is a small irregular mass in the anterior (cephalic) mediastinum; it is about $\frac{1}{2}$ inch long by $\frac{1}{4}$ inch broad, and is divided into two lobes, which communicate across the middle line in two places. In the fœtal specimen the thymus is not very large, and it does not relatively occupy much more of the thorax than in the adult. The *Adrenals* are situated as usual just anterior to the kidneys; the left is a good deal larger than the right, and is rather further from the kidney.

The Nervous System.

The Cranial Nerves.—No difference was noticed between these nerves and those of the Rabbit, except that no ansa hypoglossi was found. The sterno-hyoid and sterno-thyroid muscles were supplied by branches from the second and third cervical nerves. As the loop

of communication between the descendens hypoglossi and the upper cervical nerves is always present in the Rabbit, I only wish to record that I failed to find it in this specimen of *Pedetes*; I may have cut it away or this may have been an abnormal specimen.

Brachial Plexus.—There is reason to believe that the limb plexuses of mammals nearly related differ not only in their arrangement but also in the number of spinal nerves which go to form them. I am led to this belief from the fact that in 1887 Professor Paterson figured the limb plexuses of *Atherura fasciculata* (Journal of Anatomy, vol. xxi. p. 611). In 1894 I figured those of *Atherura africana* (P. Z. S. 1894, pp. 688 & 690). At that time I had not read Prof. Paterson's paper, so that the two observations were quite independent of one another. In my animal the fifth cervical nerve certainly entered into the brachial plexus, while in Prof. Paterson's it was quite independent of it. It seems therefore important to figure or describe limb plexuses whenever possible in order to find out how far they are constant structures. In *Pedetes* the brachial plexus is made up of the 5th, 6th, 7th, and 8th cervical nerves and the 1st thoracic. The 5th and 6th nerves unite to form the outer cord, and it is interesting to notice that this cord receives no communication of any kind from the 7th.

The 7th and 8th cervical and 1st thoracic nerves unite to form the inner cord, while the posterior cord is made up of fibres derived from all the roots entering the plexus.

The suprascapular nerve rises from the 5th cervical nerve only; in Paterson's specimen of *Atherura* it came from the 6th, while in my specimen of the same animal it came from the 5th, with a small branch from the 6th. My own observations make me believe that the 5th cervical is its usual origin in mammals.

The nerve to the subscapularis (upper subscapular) comes from the junction of the 5th and 6th cervicals.

The musculo-cutaneous nerve rises from the outer cord, passes above the coraco-brachialis (between it and the humerus) and supplies it; then it gives off two branches to the flexor brevis cubiti (brachialis anticus), and one to the flexor longus cubiti (biceps); after this it becomes cutaneous in the forearm as usual.

The median nerve rises by a head from the inner and one from the outer cord; these unite in the axilla and the nerve runs down the arm on the outer side of the brachial artery, with which it passes through the fibrous supracondylar foramen. At the bend of the elbow a bundle of branches is given off which supplies all the muscles of the flexor surface of the forearm except the flexor carpi ulnaris and the flexor sublimis digitorum; the deepest of these branches, the one supplying the pronator quadratus, corresponds to the human anterior interosseous nerve. A little lower down a cutaneous branch is given off which supplies the lower part of the flexor surface of the forearm and the palm. About the middle of the forearm the nerve divides into two branches of equal size, which run side by side with the median artery to the hand: the more ulnar of these is the larger and supplies all four digital clefts as well as the radial side of the pollex and the ulnar side of the

minimus; the more radial one supplies the thenar muscles and reinforces the second and third digital clefts.

The ulnar nerve comes from the inner cord and runs down on the inner side of the brachial artery, passes deep to the epitrochleo-anconeus muscle, which it supplies, and in the forearm only supplies the flexor carpi ulnaris and the flexor sublimis digitorum, no branch being given to the flexor profundus. After this the nerve passes to the deep part of the hand and supplies all the muscles of the palm except those of the thenar eminence. The usual dorsal cutaneous branch is given off to supply one and a half digits on the ulnar side of the hand. It will thus be seen that in this specimen of *Pedetes* there has been an exchange of fibres usually bound up in the ulnar and median nerves respectively. The flexor sublimis digitorum is entirely supplied by the ulnar, an arrangement which has already been observed in many mammals by Professor K. von Bardeleben; but, on the other hand, the whole of the flexor profundus digitorum and all the digits on their palmar surfaces are supplied by the median.

The internal cutaneous nerve comes from the inner cord and supplies the skin of the inner side of the arm and forearm. There is no separate lesser internal cutaneous, but the lateral cutaneous branch of the second intercostal (intercosto-humeral) crosses the axilla and supplies the skin of the upper part of the inner side of the arm.

The internal and external anterior thoracic nerves come off from the internal and external cords respectively and form a loop from which the pectorals are supplied; from the internal anterior thoracic a large branch (lateral cutaneous nerve of the thorax) passes back to supply the abdomino-humeralis portion of the panniculus as well as part at least of the pectoralis quartus[1]. The musculo-spiral nerve derives fibres from the dorsal divisions of all the trunks entering the brachial plexus; that, however, from the first thoracic joins it, after the circumflex and subscapular branches have been given off; the nerve winds round the back of the humerus as usual, supplying the triceps, latissimo-olecranalis, anconeus, and skin of the back of the arm and forearm, but no branch is given to the flexor brevis cubiti (brachialis anticus). In front of the external condyle it divides as usual into radial and posterior interosseous, the former supplying three and a half radial digits on their dorsal surfaces, the latter all the extensor muscles of the forearm.

The circumflex nerve comes off from the combined dorsal divisions of the 5th and 6th nerves, so that it can only obtain fibres from these. It pursues the usual course and supplies the teres minor and all three parts of the deltoid.

The middle and lower subscapular nerves rise from the musculo-spiral before the dorsal division of the first thoracic has joined that nerve. The middle subscapular supplies the latissimus dorsi

[1] Professor Birmingham has published a masterly discussion on this subject in the 'Journal of Anatomy,' vol. xxiii. p. 206.

only; the lower supplies chiefly the teres major, but, as in man, gives a small branch to the lower part of the subscapularis.

Lumbo-Sacral Plexus.—The nerves which enter into this plexus are the 4th, 5th, 6th, and 7th lumbar, and the 1st and 2nd sacral. The genito-crural nerve rises from the 4th lumbar, appears on the surface of the psoas, and passes down to the middle of Poupart's ligament, where it is distributed to the skin of the groin.

The external cutaneous rises from the fourth and fifth lumbar nerves and pursues its usual course to the outer side of the thigh; this it supplies, as well as the platysma, which is here well developed. The anterior crural comes from the fifth and sixth lumbar and appears on the outer side of the psoas. At Poupart's ligament it divides into a superficial and a deep division. The superficial supplies the skin of the front and inner side of the thigh, and, owing to the feeble development of the ilio-tibialis (sartorius), the long saphenous is part of this division. The long saphenous supplies the inner side of the leg as far as the foot, but it lies considerably anterior to the long saphenous artery. The deep division of the anterior crural supplies the deep muscles of the front of the thigh.

The obturator nerve also rises from the fifth and sixth lumbar, and passes through the obturator foramen to supply the obturator externus and adductors.

The great sciatic nerve comes from the sixth and seventh lumbar and the first sacral; before it leaves the sciatic notch it gives off a nerve to the hamstrings and about the middle of the thigh an extra branch to the flexor cruris lateralis (biceps). In the lower half of the thigh it divides into external and internal popliteal, but these nerves, as Paterson points out, are capable of being separated quite up to their commencement. When this was done it was found that both of them, as well as the nerve to the hamstrings, obtained fibres from the sixth and seventh lumbar and first sacral nerves; the fibres of the nerve to the hamstrings were most ventral, then those of the internal popliteal, while the external popliteal fibres were most dorsal.

The nerve to the hamstrings breaks up into five branches; two of these enter the semitendinosus, two the flexor cruris lateralis (biceps), while the fifth supplies the semimembranosus and presemimembranosus. It will thus be seen that the flexor cruris lateralis has three separate nerves entering it.

Before dividing into external and internal popliteal the great sciatic nerve gives off two cutaneous branches: one of these supplies the skin on the outer side of the leg; the other one, corresponding to the short saphenous of human anatomy, runs down the back of the calf and supplies the outer side of the foot. It has already been said that the great sciatic divides in the lower half of the thigh, and of its two branches the internal popliteal is considerably the larger; this branch supplies the superficial and deep muscles of the calf, and is continued on as the posterior tibial to the sole; here it divides into internal and external plantar, the

former supplying all four toes, the latter passing deep to supply the muscles. The external popliteal nerve divides into musculocutaneous, which runs down among the peroneals to the dorsum of the foot, and the anterior tibial, which breaks up into twigs for the extensor muscles of the leg, one fine branch descending to supply the extensor brevis digitorum muscle.

The small sciatic, internal pudic, and inferior gluteal nerve come from the 1st and 2nd sacral nerves; they have practically the human distribution. The 3rd, 4th, 5th, and 6th nerves form a long cord which runs along the side of the tail.

Summary of Points of Interest.

1. *Pedetes* possesses only two pairs of teats, showing that it is not in the habit of bringing forth many young at a birth; the presence of only one fœtus in the uterus confirms this.

2. The upper incisors of *Pedetes* are smooth, those of *Dipus* are grooved, but the embryo of *Pedetes* also has grooved incisors.

3. The presence of the nail in the palm of *Pedetes*, described by Bardeleben, is confirmed.

4. Bardeleben's description of the radial ossicle or prepollex exactly describes this specimen; in the fœtus the radial ossicle is a definite cartilaginous structure.

5. In the foot a structure apparently serially homologous with the radial ossicle was found; but it was attached to the distal instead of to the proximal row of tarsal bones.

6. The trachea was divided into two by a vertical septum.

7. There was no gall-bladder.

8. A study of the muscles showed that *Pedetes* was allied to the Dipodidæ, but had more hystricomorphine tendencies than those animals.

3. On new Species of Spiders from Trinidad, West Indies. By Frederick O. Pickard Cambridge, B.A.

[Received October 18, 1898.]

(Plate LIV.)

In this communication I propose to give descriptions of three new species of Spiders based on specimens collected by Dr. Walter Ince and Mr. Thos. Potter, of Port-of-Spain, Trinidad, and of one new species of which specimens are in the collection of the British Museum from the same locality.

The total number of species of Spiders from this island now represented in the British Museum amounts to eleven only, so that our friends who have been good enough to supply us with material will perceive that further consignments from that locality will be much appreciated.

The examination of Dr. Ince's collection has led to a very